24(2)

AUTHORS: Zheludev, I. S., Gladkiy, V. V., Rusakov, L. Z., Rez, I. S. SOV/48-22-12-14/33

TITLE: On Non-Linear Properties of Single Crystals of $BaTiO_3$ With Additions of Pb and Single Crystals of Triglycine Sulfate in a Strong Electric Field (O nelineynykh svoystvakh monokristallov $BaTiO_3$ s dobavkami Pb i monokristallov triglitsinsul'fata v sil'nom elektricheskom pole)

PERIODICAL: Izvestiya Akademii nauk SSSR. Seriya fizicheskaya, 1958, Vol 22, Nr 12, pp 1465-1468 (USSR)

ABSTRACT: The hysteresis interrelation between electric voltage and charge is characteristic of a piezoelectric condenser. Assuming that this interrelation is determined by the idealized loop shown in figure 1, a connection between various harmonics of charge, of voltage of the alternating and the constant field and the geometrical characteristics of the loop can be found in accordance with Mezon's method (Ref 1). The triglycine sulfate and $BaTiO_3$ single crystals investigated have shown a strong non-linearity (for triglycine sulfate $N \approx 80$, for $BaTiO_3$ $N \approx 30$)

Card 1/2

On Non-Linear Properties of Single Crystals of $BaTiO_3$ With Additions of Pb and Single Crystals of Triglycine Sulfate in a Strong Electric Field

SOV/48-22-12-14/33

in the strong electric field ($E_m > E_k$) and high values of the loss angle $tg\delta$ (for triglycine sulfate $tg\delta_{max} = 3.8$ for $BaTiO_3$ $tg\delta_{min} = 1.2$). In triglycine sulfate single crystals a considerable divergence of the curves illustrating the dependence of the dielectric constant ε on the field tension (of both, the alternating and the constant field), which were plotted at an increase and decrease of the voltage, was observed. This divergence of ε curves indicates a good electric "memory" of triglycine sulfate. There are 6 figures and 2 references, 1 of which is Soviet.

ASSOCIATION: Institut kristallografii Akademii nauk SSSR (Institute of Crystallography, Academy of Sciences, USSR) TsNILP Komiteta po radioelektronike Soveta Ministrov SSSR (TsNILP of the Committee of Radioelectronics of the Council of Ministers, USSR)

24(3)

AUTHORS: Zhuvalov, L. A., Kachkacheva, M. M., Rusakov, L. Z., Zheludev, I. S. SOV/48-22-12-27/33

TITLE: On Low-Temperature Polarization of Ceramics From Barium Titanate (Nizkotemperaturnaya polyarizatsiya keramiki iz titanata bariya)

PERIODICAL: Izvestiya Akademii nauk SSSR .Seriya fizicheskaya, 1958, Vol 22, Nr 12, pp 1516 - 1519 (USSR)

ABSTRACT: The present paper deals with tests of the polarization and the sub-polarization of $BaTiO_3$ ceramics in rhombic phase. This polarization has been called the low-temperature polarization. These tests were made on the assumption that it might be possible to obtain higher values of piezomoduli of ceramics in the rhombic and tetragonal phase by such a polarization in relatively small fields. The low-temperature sub-polarization in the rhombic phase causes an increase of the values of the piezomoduli of ceramics in the tetragonal phase. On heating under the field the subpolarization causes an increase of the d_{31} by an average 15%. In spite of the noticeable ageing the d_{31}

Card 1/2

On Low-Temperature Polarization of Ceramics From Barium Titanate 307/48-22-12-27/33

value remains by more than 10% above the initial value. Heating under the field after polarization in the rhombic phase prevents the d_{31} from becoming smaller during the transition into the tetragonal phase. The polarization in the rhombic phase with heating under the field requires smaller fields than a polarization at room temperature. The d_{31} values do not become smaller, but in numerous cases even higher than with hot polarization. For this reason the low-temperature polarization can be used along with hot polarization, particularly when the latter is not feasible, for example on account of strong conductivity in the proximity of the Curie (Kyuri) point. The authors thank V. G. Zatevakhina for his collaboration. There are 1 figure, 3 tables, and 5 references, 4 of which are Soviet.

ASSOCIATION: Institut kristallografii Akademii nauk SSSR (Institute of Crystallography, Academy of Sciences USSR) TsNILP Komiteta po radioelektronike Soveta Ministrov SSSR (TsNILP of the Committee on Radioelectronics, Cabinet Council, USSR)

Card 2/2

24(3)

AUTHORS: Spivak, G. V., Igras, E., Zheludev, I. S. SOV/20-122-1-14/44

TITLE: On the Peculiarities of the Domain Structure of Ferroelectrics, Made Apparent by Electron Microscope Visualization (Ob osobennostyakh domennoy struktury segnetoelektrikov, vyyavlyayemykh pri elektronnomikroskopicheskoy vizualizatsii)

PERIODICAL: Doklady Akademii nauk SSSR, 1958, Vol 122, Nr 1, pp 54-57 (USSR)

ABSTRACT: If the extraordinarily important rôle of the domains of the ferroelectrics for the understanding of their physical properties and of the nature itself of the ferroelectrical phenomena is taken into account, the application of electron microscopy for the purpose of completing the laws concerning the orientation of the domains (of the characteristic features of their boundaries and of their dimensions) offer many possibilities. According to the authors' investigations, the domain structure of the ferroelectrics may be visualized by means of a translucent microscope according to the method of the imprints. These imprints must reproduce the fine structure of the electric field. This was possible because of the

Card 1/4

existence of a natural raised profile (rel'yef) of the ferroelectric poly-domain crystal. This raised profile of the surface is caused by mechanical tensions on the boundaries of the domains which, in turn, are caused by the interaction of their electric dipoles. The use of a translucent electron microscope and of colloid and coal imprints permitted the detection of the domain structure on crystals of barium titanate and potassium sodium tartrate enlarged 25 000-fold. The domain structure of the ferroelectrics may be observed on imprints taken immediately from non-processed crystals and from etched crystals. The authors etched crystals of $BaTiO_3$ in concentrated hydrochloric acid for 5 - 10 minutes. The processing of the samples is described in a few lines. The authors then describe the results of the preliminary investigation of the domain structure by means of an optical microscope. According to the electron microscopic investigation, the domain structure of the natural (not etched) faces of $BaTiO_3$ is sufficient for the taking of very qualitative imprints. This natural profile is caused by spontaneous de-

formations (which are connected with electrostriction phenomena) of the domains. A figure shows a typical picture of the domain structure of $BaTiO_3$ in 1000-fold enlargement. With an 8000-fold enlargement, the authors detected details of the shape of a single domain. In the case of still greater enlargements (25 000-fold) the details of the boundary between the domains and some details of the structure of the individual domains may be discerned. The domains detected by electron microscopical investigation are smaller by one order of magnitude than the optically observed domains. This subdomain structure is very interesting for the detection of some properties of the ferroelectrics. The results of this paper concern single crystals of $BaTiO_3$ and potassium sodium tartrate. The authors thank V. I. Osokina and T. F. Filippova for their help and V. A. Timofeyeva who placed the single crystals of $BaTiO_3$ at the authors' disposal. There are 4 figures and 7 references, 4 of which are Soviet.

On the Peculiarities of the Domain Structure of Ferroelectrics, Made Apparent by Electron Microscope Visualization SOV/20-122-1-14/44

ASSOCIATION: Moskovskiy gosudarstvennyy universitet im. M. V. Lomonosova (Moscow State University imeni M. V. Lomonosov)
Institut kristallografii Akademii nauk SSSR (Institute of Crystallography, AS USSR)

PRESENTED: April 29, 1958, by A. V. Shubnikov, Academician

SUBMITTED: April 25, 1958

Card 4/4

AUTHORS: Igras, E., Spivak, G.V. and Zheludev, I.S. SOV/70-4-1-23/26

TITLE: Microrelief and Domain Structure on the Surface of a Single Crystal of Barium Titanate (Mikrorel'yef i domennaya struktura na poverkhnosti monokristalla titanata bariya)

PERIODICAL: Kristallografiya, 1959, Vol 4, Nr 1, pp 121-123 + 1 plate (USSR)

ABSTRACT: The surface structure of a single crystal of $BaTiO_3$ has been studied above and below the Curie point by optical reflection microscopy and by stereo-electron microscopy. Surface deformations of two types were found: 1) elastic, disappearing above the Curie point and 2) inelastic, remaining above the Curie point. Crystals made in various ways behaved differently. Electron microscope stereopairs were measured photogrammetrically and gave a value of 600 Å for the depth of the relief bands in a "quasi-elastic" example. In an inelastic specimen the corresponding depth was 2 000 Å. The form of the relief waves appeared rectangular. The relief seems to

Card1/2

Microrelief and Domain Structure on the Surface of a Single Crystal of Barium Titanate

be due to strains arising from the tetragonality of the unit cell of $BaTiO_3$ (c/a = 1.01 at 20 °C) on polarisation and there is some possibility that it could be used for estimating the polarisation. There are 4 figures and 8 references, 3 of which are Soviet and 5 English.

ASSOCIATION: Moskovskiy gosudarstvennyy universitet imeni M.V. Lomonosova (Moscow State University imeni M.V. Lomonosov)

SUBMITTED: August 10, 1958

Card 2/2

AUTHORS: Spivak, G.V., Igras, E., Pryamkova, I.A. and Zheludev, I.S. SOV/70-4-1-24/26

TITLE: Observations of the Domain Structure of Barium Titanate by Means of an Electron Mirror (O nablyudenii domennoy struktury titanata bariya pri pomoshchi elektronnogo zerkala)

PERIODICAL: Kristallografiya, 1959, Vol 4, Nr 1, pp 123 - 125 + 1 plate (USSR)

ABSTRACT: It has been shown that it is possible to obtain by means of an electron mirror a qualitative representation of the domain structure of a ferroelectric with a magnification of up to several hundred times. The mechanism of image formation differs from that in optical polarisation microscopy. Earlier devices (Ref 2) used a magnetic field for the "magnetic contrast effect" but this caused instability. An electron beam from a gun is accelerated by 20 kV and passes through a hole in a fluorescent screen to the specimen where it is reflected. The system is roughly analogous to that of an ordinary microscope with incident illumination supplied through the eyepiece.

Card1/2

Observations of the Domain Structure of Barium Titanate by Means of an Electron Mirror SOV/70-4-1-24/26

Examples are reproduced of images from $BaTiO_3$ single crystals at 800X and 150X and a resolution of about 200 lines/mm was achieved. The reflection of the slow electrons is due to the fringing field between the domains. There are 5 figures and 10 references, 6 of which are Soviet, 3 English and 1 French.

ASSOCIATION: Moskovskiy gosudarstvennyy universitet imeni M.V. Lomonosova (Moscow State University imeni M.V. Lomonosov)

SUBMITTED: August 10, 1958

Card 2/2

AUTHORS: Shuvalov, L.A., Aleksandrov, K.S. and Zheludev, I.S. SOV/70-4-1-26/26

TITLE: On the Question of the Domain Structure of Crystals of Triglycine Sulphate (K voprosu o domennoy strukture kristallov triglitsinsul'fata)

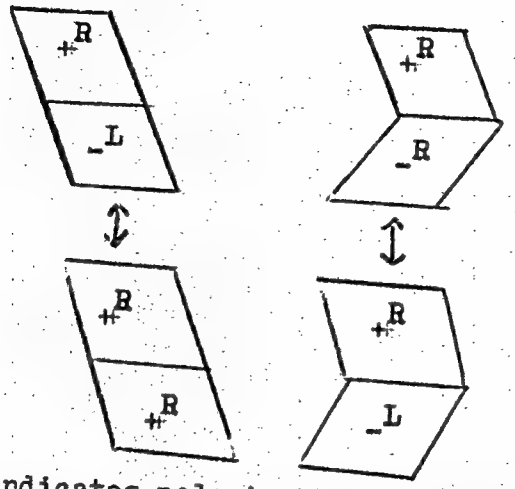
PERIODICAL: Kristallografiya, 1959, Vol 4, Nr 1, pp 130 - 132 (USSR)

ABSTRACT: $(NH_2CH_2COOH)_3.H_2SO_4$ is isomorphous with the selenate and the fluoberyllate and several other ferroelectrics which pass from the class $2/m \rightleftarrows 2$ at the Curie point. Possible ways in which the domains can be twinned are discussed here. Besides the symmetry of the transition $2/m \rightleftarrows 2$ the only other assumption is that in the ferroelectric state with no imposed field, the mosaic crystal has no overall moment. Two and only two mutual orientations of the domains are found. These are:

Card1/3

On the Question of the Domain Structure of Crystals of Triglycine Sulphate

SOV/70-4-1-26/26



unpolarised

polarised

Card2/3 "+" indicates polarisation towards the observer and "-" the opposite. The left possibility has the symmetry 2 (the symmetry of a single domain) in the polarised state whereas the right possibility has the symmetry 2/m . In

the latter case the moduli d_{14}, d_{25} and d_{36} vanish. If the left variant obtains then only one enantiomorphous form remains after the transition. Here, in contradistinction to the case of Rochelle salt, mechanical strains do not accompany the polarisation. Such a transition, from one enantiomorph to the other, has not been reported before. The right variant would also have similar transitions. Both types of transitions are expected to exist.
There are 1 figure and 8 references, 3 of which are Soviet, 3 English and 2 international.

ASSOCIATION: Institut kristallografii AN SSSR (Institute of Crystallography of the Ac.Sc., USSR)
Krasnoyarskiy institut fiziki AN SSSR (Krasnoyarsk Institute of Physics of the Ac.Sc., USSR)

SUBMITTED: October 21, 1958

SOV/70-4-2-25/36

AUTHORS: Yurin, V.A. and Zheludev, I.S.

TITLE: The Influence of Thermal Treatment on the Electric Properties of Rochelle Salt Containing Impurities (Vliyaniye termicheskoy obrabotki na elektricheskiye svoystva segnetovoy soli, soderzhashchey primesi)

PERIODICAL: Kristallografiya, 1959, Vol 4, Nr 2, pp 253-255 (USSR)

ABSTRACT: Rochelle salt crystals damaged by γ-radiation and also crystals grown from solutions containing impurities have been studied. Crystals were grown from a solution containing 2% $CuCO_3$. It was found that an abnormal loop was obtained which returned to normal after annealing at 40-45° for some hours with slow cooling (1-2 hours) to room temperature. After some 200 hours "rest" at room temperature the abnormal loop returned. Measurements were made on an X-cut crystal at 50 c.p.s. A minimum field strength is needed to establish the abnormal double loop and this depends on the times of exposing the specimen at different temperatures. It follows that the arising in the crystal of the state in which a double hysteresis loop is observed takes place

Card1/3

The Influence of Thermal Treatment on the Electric Properties of Rochelle Salt Containing Impurities

only in the presence of a domain structure, the domains being in a state of rest. If the specimen is exposed to a temperature lying outside the Curie interval (where the domain structure is present) then the state in which the normal hysteresis loop is observed can be retained as long as necessary. If the specimen is at a temperature between the Curie point but a constant or alternating electric field is applied to it, under the action of which the crystal either becomes a single domain or undergoes a continuous process of reorientation of the domains, then the state with the normal hysteresis loop is also retained. Graphs of the temperature dependence of dielectric susceptibility of specimens under different conditions are given. There are 5 references, 4 of which are Soviet and 1 Japanese and 3 figures.

SOV/70-4-2-25/36

The Influence of Thermal Treatment on the Electric Properties of Rochelle Salt Containing Impurities

ASSOCIATION: Institut kristallografii AN SSSR (Institute of Crystallography of the Ac.Sc.USSR)

SUBMITTED: October 21, 1958

Card 3/3

SOV/70-4-3-26/32

AUTHORS: Zheludev, I.S. and Sonin, A.S.

TITLE: Rotation of Plane of Polarisation of Light and the Symmetry of Crystals

PERIODICAL: Kristallografiya, 1959, Vol 4, Nr 3, pp 425-429 (USSR)

ABSTRACT: The changes in the symmetry of crystals conditioned, in the general case, by the changes (appearance, change of sign, change of magnitude) in the specific rotation ρ of the plane of polarisation of light are investigated. The specific rotation in one direction is described by an axial tensor of symmetry $\infty : 2$. The gyration surface of a crystal can belong to one of the four symmetry groups 2:2, $\bar{4}$.m, ∞:2 and ∞/∞. The morphological symmetry groups of crystals which show rotation either coincide with these groups or their sub-groups. Point groups which can show rotation are 1,2,3,4,6, 2:2, 3:2, 4:2, 6:2, m, 2.m, 4.m, 3/4, 3/2, $\bar{4}$.
A change in the point symmetry of a crystal on phase transition conditioned by a change in the rotation can be found from Curie's principle (A.V. Shubnikov - Ref 4).

Card1/2

Rotation of Plane of Polarisation of Light and the Symmetry of Crystals

According to this principle the symmetry of the crystal on change of rotation can be determined as the highest common sub-group of the point group to which the crystal belongs in its initial state and the symmetry group of the gyration surface for the given disposition of the symmetry elements of both groups. Hence, for any of the 32 classes the change in symmetry connected with a change in rotation can be found. This is tabulated for all classes and for the 4 symmetries of gyration surface. There are 5 tables and 4 Soviet references.

ASSOCIATION: Institut kristallografii AN SSSR (Institute of Crystallography of the Ac.Sc., USSR)

SUBMITTED: March 17, 1959

SOV/70-4-4-5/34

AUTHORS: Sonin, A.S. and Zheludev, I.S.

TITLE: Spatial Symmetry and Ferroelectric Phase Transitions

PERIODICAL: Kristallografiya, 1959, Vol 4, Nr 4, pp 487-497 (USSR)

ABSTRACT: Tables are given showing, for each of the 230 space groups, the space groups which result when a crystal of the initial space group undergoes a ferroelectric transition developing a spontaneous polarisation P_s along one of the axes $\langle 100 \rangle$, $\langle 111 \rangle$, $\langle 110 \rangle$, $\langle hk0 \rangle$, $\langle hkk \rangle$, $\langle hhk \rangle$ or $\langle hkl \rangle$ (for the cubic case) or other appropriate axes for the other crystal systems. Examples of 17 experimental transitions in various crystals are collected and all agree with the theoretical scheme. The tables can be used to predict the symmetry on transition, to limit the search for ferroelectric transitions or to find the directions of polarisation.
The groups are obtained by taking the highest common sub-group of the symmetry group of the crystal class in the para-electric state and the symmetry group of the

Card1/2

Spatial Symmetry and Ferroelectric Phase Transitions

polar vector $\bar{P}_c$, of symmetry $\infty.m$, in the given orientation of crystal and polarisation symmetry elements. A ferroelectric in its polarised state can belong to one of only 68 space groups of the 10 pyroelectric classes (with polar directions). There are 7 tables and 19 references, of which 7 are Soviet, 8 English, 1 international, 2 German and 1 Japanese.

ASSOCIATION: Institut kristallografii AN SSSR (Institute of Crystallography of the Ac.Sc. USSR)

SUBMITTED: May 4, 1959

AUTHOR: Zheludev, I.S. SOV/70-4-4-16/34

TITLE: The Oscillations of Dielectric Pendulums

PERIODICAL: Kristallografiya, 1959, Vol 4, Nr 4, pp 571-574 (USSR)

ABSTRACT: It has been established that pendulums containing certain dielectric are able to oscillate without excitation and on application of electric fields to execute forced oscillations. A disc of dielectric with electrodes fixed to it is fixed to a stiff metal spring and oscillates perpendicular to it. The motion is recorded by the reflexion of a beam of light from a mirror on the pendulum. Y-cut crystals of $Li_2SO_4 \cdot H_2O$ and x-cut discs of Rochelle salt oscillated spontaneously at the natural frequency of the mechanical system (~20 c.p.s.). This occurred both with shorted and open circuit electrodes. The amplitude was variable often pulsing at 1 - 1/100 c.p.s. The temperature dependence was studied over the range +10 - + 35 °C for Rochelle salt and showed a λ-type curve with a pronounced maximum at about 24 °C. The amplitude A was proportional to $\partial P/\partial t$, where P is the spontaneous polarisation.

Card1/2

The Oscillations of Dielectric Pendulums SOV/70-4-4-16/34

The effect is thus related to fluctuations in the pyroelectric polarisation. Oscillations could be forced in all cases of known ferroelectrics. An alternating field of 5-6 kV/cm was applied. X-cut Rochelle salt, Y-cut triglycine sulphate, Z-cut GASH and discs of unpolarised ceramic $BaTiO_3$ were all active. The oscillations ceased when the temperature exceeded the Curie point of the material. The field dependence of the amplitude was also studied. The effect is the formal analogy of the Einstein-de Haas effect in the magneto-mechanical field. There are 5 figures.

ASSOCIATION: Institut kristallografii AN SSSR (Institute of Crystallography of the Ac.Sc., USSR)

SUBMITTED: April 3, 1959

Card2/2

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75992
SOV/70-4-5-14/36

AUTHORS: Zheludev, I. S., Romanyuk, N. A.

TITLE: Study of the Piezoelectric Polarization of the Rochelle Salt Crystals According to the Domain Structure Observations

PERIODICAL: Kristallografiya, 1959, Vol 4, Nr 5, pp 710-717 (USSR)

ABSTRACT: Shul'vas-Sorokina, R. D. [Ref 2. Journal of Technical Physics, 1, 8, 756-760 (1931), achieved the maximum polarization of the Rochelle Salt crystals in 4-5 minutes applying 0.5 kg/cm^2 pressure under 45° to the polar axis. The authors cut the Rochelle Salt crystals into 10 x 10 x 0.6 to 1.4 mm plates, inclined under 45° to the X axis. Then, the plates were polished, covered with glycerin and glass, and those plates that had large c-domains or b- and c-domains were tested at 8 ± 0.1° C by the device shown in Fig. 1, which has two lever + piston sets transverse to each other and enables the compression of a plate simultaneously or alternately along the bisectors between the Y and Z

Card 1/3

Study of the Piezoelectric Polarization of the Rochelle Salt Crystals According to the Domain Structure Observations

75992
SOV/70-4-5-14/36

axes. Placed in a thermostat on the stage of a microscope, the device permits one to observe the domain alterations in the course of compression, to control and measure temperature changes by a thermocouple, and periodically to take microphotos. Thus, domain areas were measured on microphotos with an accuracy of ±2 to 3%. The deformations can also be expressed in terms of stress instead of strain due to which the orthorhombic crystals turn into monoclinic. Compressing alternately in two directions, the plates were turned into monodomain, then into polydomain, and again into monodomain states. The experiments disclosed that loads below the coercive stress of about 200 g/cm^2 do not change the domain structure even applied for 2 to 5 hours. Near the coercive stress change of the area of a growing domain is described by $S(t) \sim \exp(-\alpha/t)$, where α for a 0.94-mm-thick plate at 180 g/cm^2 stress and 10° C was 6.2 min; and t, the duration in minutes. The same equation is valid if the coercive field of about 40 v/cm is con-

Card 2/4

Study of the Piezoelectric Polarization of the Rochelle Salt Crystals According to the Domain Structure Observations

75992
SOV/70-4-5-14/36

sidered instead of the coercive stress. The application of electric fields or stresses (see Fig. 5) produced nearly rectangular hysteresis loops. The relationship between the applied stress, Y_z or Y_y, and the equivalent electric field, E_x, parallel to the X axis is described by $Y_z = Y'_y = e_{14}E_x$, where e_{14} is the piezoelectric constant. There are 10 figures; 1 table; and 13 references, 8 Soviet, 2 U.S., 2 Japanese, 1 German. The U.S. references are: H. H. Wieder, J. Appl. Phys., 27, 4, 413-416 (1957); F. C. Isely, Phys. Rev., 24, 5, 569-574 (1924).

ASSOCIATION: Crystallographical Institute of the Academy of Sciences of the USSR (Institut kristallografii AN SSSR).

SUBMITTED: May 9, 1959

Card 3/3

SOV/70-4-5-15/36

AUTHORS: Gurevich, V. M., Zheludev, I. S., Rez, I. S.

TITLE: Some of the Electric Conductivity Characteristics of Guanidine Aluminum Sulfate Hexahydrate

PERIODICAL: Kristallografiya, 1959, Vol 4, Nr 5, pp 718-722 (USSR)

ABSTRACT: The authors describe the method and results of the resistivity measurements conducted by the use of direct current, applied to the single-crystal plates of guanidine aluminum sulfate hexahydrate, whose ferroelectricity has been known since 1955. The plates, 1 cm^2 and 1-2 mm thick, cut off transverse to the Z axis from different pyramids of growth of an artificial single crystal of the compound, were silvered sublimating thin Ag films under vacuum, dried, some polarized by an applied field above the coercive field, and the susceptibilities of both polarized and natural (nonpolarized) plates were measured by IIIev-2 in dry air (above H_2SO_4). No

Card 1/4

dehydration occurred. The resistivity changes in the course of polarization at 3 different fields (a-curves), and the required time for the complete polarization at various fields, E, (b-curve), are illustrated in Fig. 1. The measurements at various temperatures disclosed anomalous (higher) resistivities at the moment of polarization at about 50° C except in the case of existence of a residual polarization. In the vicinity of 50° C the spontaneous polarization also takes place, an abrupt change of the piezoelectric effect and of the $\frac{\rho_1}{\rho_3}$ ratio see (Fig. 4). ρ_1 means resistivity at the moment of complete polarization of natural plates; ρ_3, the same of plates that have been polarized previously. It is still not known whether the temperature interval of anomalies is related to the temperature of growth, which in this case was 40°-60° C. There are 6 figures; and 4 references, 2 Soviet, 2 U.S., The U.S. references are A. N. Holden, et al., Phys. Rev., 98, 546 (1955).

ZHELUDEV, I.S

Kinetics of forming a photoelectretic state in sulfur monocrystals. N. T. Kashukeev, V. M. Fridkin, and I. S. Zheludev. *Izvest. Bulgar. Akad. Nauk., Otdel. Fiz. Mat. i Tekh. Nauki Ser. Fiz.* 7, 71–9(1956)(English summary, 80–1).—An attempt is made to explain certain expti. results obtained during the study of photoelectrets, by starting from the kinetics of photopolarization. The process of filling the local levels with electrons in the energy level scheme is described by the following equations: (I) $dn/dt = d + KN - \beta n(M - N) - \alpha nP$, where d is the no. of electrons passing from the normal ground level to the cond. level under action of light of intensity E per unit vol. and unit time, n is electron concn. in the cond. level, M is concn. of local levels, N is concn. of electrons in the local levels, P is concn. of holes in the normal level; (II) $dN/dt = Q + \beta n(M - N) - kN - \gamma NP$, where Q is the no. of electrons passing from the normal level into the local levels per unit vol. in unit time owing to thermal motion, α, β, and γ are coeffs. of recombination; (III) $dP/dt = d_1 + Q - \alpha nP - \gamma NP$, and (IV) $P = N + n$. In the detn. of the dependence of N on time this value can be considered proportional to the charge of the photoelectret. At ordinary temps. $Q = 0$ and with not too strong light and sparsely filled local levels the ratios n/M and N/M may be considered small. Under these conditions if one is confined to linear terms and considers the no. of electrons passing from the filled local levels to the cond. level under the action of light, d_1 is much smaller than d_1, then the linear equations (I) and (II) take on the form: (V) $dn/dt + \beta Mn - d = 0$ and (VI) $dN/dt + KN - \beta Mn = 0$. Solving these equations for $N(0) = n(0) = 0$, (VII) $N = N_s(1 - e^{-\beta Mt})$. The electron concn. of the stationary system $N_s = S_1/S_2$; S_1 and S_2 are coeffs. depending on the light absorption and quantum field. Expression (VII) describes the effect of satn. of the photoelectret charge on the duration of polarization and on light intensity. The charge of photoelectrets is a function of Et which means that the law of mutual substitution that applies to photochem. processes in Ag halides is valid also for photoelectrets. The validity of this deduction is fully confirmed by expti. results. If the thermal transitions of electrons from the normal levels to the local levels is taken into account, i.e., $Q = 0$ then the equations (I) and (II) after solving equations (II) and (III) for $Q = q(M - N)e^{-u/kT}$ (u is activation energy) take on the following form: $N = N_s(1 - e^{-\beta_1 Mt})$ and $N_s = (S_1/S_2)(1 - qe^{-u/kT} \times M/S_1E)$, i.e., the charge of photoelectrets decreases with increasing temp.

G. A. Konstantinov

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~~24 (3), 23 (5)~~

67907
SOV/20-129-5-13/64

AUTHORS: Golovin, B. M., Zheludev, I. S., Kashukeyev, N. T., Orlov, I. N., Fridkin, V. M., Mogilevskaya, L. Ya., Antonov, A. S.

TITLE: A New Electrophotographic Process, Which May Be Realized by Means of Combined Electret Layers

PERIODICAL: Doklady Akademii nauk SSSR, 1959, Vol 129, Nr 5, pp 1008-1011 (USSR)

ABSTRACT: The present paper deals with a new electrophotographic process in which combined electret layers are used in addition to "memory properties". In 1955 Fridkin et al. (Ref 8) described electric photography by means of photoelectrets on the basis of the constant internal photoelectric polarization in dielectrics discovered by G. Nadzhakov (Ref 9). A layer of a photoelectric conductor with relatively high photosensitivity and relatively low inertia is applied to the semi-transparent electrode. The dark resistance of this layer may be very low. Onto the layer of the photoelectric conductor, a layer of a dielectric with stable dark-polarization is applied. The adjoint second electrode may then be opaque. The electrophotographic process is then realized as follows: A constant voltage is

Card 1/4

A New Electrophotographic Process, Which May Be Realized by Means of Combined Electret Layers

applied to the two electrodes. With $R_2 \gg R_3$ (R_2 dark resistance of the photoelectric conductor, R_3 - dark resistance of the dielectric) the voltage meeting the layer of the dielectric practically equals zero. Through the semi-transparent electrode an image is projected on to the surface of the photoelectric conductor. As a result of the internal photoelectric effect in the photoelectric conductor, the voltage in the corresponding exposed parts of the photoelectric conductor changes, and a stable electret state is then produced in the dielectric. The latent electrophotographic image may then be "read" by means of an electron beam. Ferroelectrics and thermoelectrets may be used as dielectrics. The characteristic curve of the combined electret layers may be determined by analyzing the kinetics of the photoelectric conductivity of the photoelectric conductor and of electret state formation. A law of mutual exchangeability of electrets is satisfied if the charge of the electret is a function of

A New Electrophotographic Process, Which May Be Realized by Means of Combined Electret Layers

$\int_0^\tau \mathcal{E}\,dt$ alone, where $\mathcal{E}$ denotes the field strength of the polarizing field and τ - the duration of polarization. The authors experimented with combined electret layers, in which cadmium sulfide (activated with copper and chlorine) were used as photoelectric conductors, and zinc sulfide (also activated with copper and chlorine) served as electret. A diagram shows the dependence of the charge of the ZnS-electret on the field strength of the polarizing field. In the interval under investigation this dependence is linear. The law of reciprocal exchangeability does not apply in the case of the combined electret layers investigated here. The authors thank Academician A. V. Shubnikov and Academician G. S. Nadzhakov for discussing the results obtained by the present paper. There are 3 figures and 17 references, 13 of which are Soviet.

67907
SOV/20-129-5-13/64

A New Electrophotographic Process, Which May Be Realized by Means of Combined Electret Layers

ASSOCIATION: Institut kristallografii Akademii nauk SSSR (Institute of Crystallography of the Academy of Sciences of the USSR). Institut fiziki Bolgarskoy Akademii nauk (Institute of Physics of the Bulgarian Academy of Sciences). Ob"yedinennyy institut yadernykh issledovaniy (Joint Institute of Nuclear Research)

PRESENTED: July 15, 1959, by A. V. Shubnikov, Academician

SUBMITTED: July 9, 1959

4

Card 4/4

ZHELUDEV, I. S.

PHASE I BOOK EXPLOITATION SOV/4485

Fridkin, Vladimir Mikhaylovich and Ivan Stepanovich Zheludev

Fotoelektrety i elektrofotograficheskiy protsess (Photoelectrets and the Electrophotographic Process) Moscow, Izd-vo AN SSSR, 1960. 205 p. Errata slip inserted. 5,000 copies printed.

Sponsoring Agency: Akademiya nauk SSSR. Institut kristallografii.

Resp. Ed.: G. S. Nadzhakov, Academician, Bulgarian Academy of Sciences; Ed. of Publishing House: V. I. Rydnik; Tech. Ed.: L. A. Lebedeva.

PURPOSE: This book is intended for scientists working in the field of electrets.

COVERAGE: The book is described as the first serious attempt at a systematic presentation of the results of investigations carried out from 1955 to 1959 in the field of photoelectrets by the Laboratoriya elektricheskikh svoystv kristallov Instituta kristallografii AN SSSR (Laboratory of the Electrical Properties of Crystals of the Institute of Crystallography, Academy of Sciences USSR) and the Fizicheskaya laboratoriya Nauchno-issle-

Card 1/5

dovatel'skogo instituta poligraficheskogo mashinostroyeniya (Physics Laboratory of the Scientific Research Institute of Printing Machinery). The authors also include work done by the Institute of Crystallography, Academy of Sciences USSR, the Physics Institute of the Bulgarian Academy of Sciences, and the Ob"yedinennyy institut yadernykh issledovaniy (Joint Institute of Nuclear Research) on photoelectrets and the possibilities of their utilization. All this material has been published in the periodical literature. Ch. I surveys problems of thermoelectret research. Ch. II deals mainly with photoelectrets. Ch. III is devoted to the electrophotographic process with emphasis on electrophotography on photoelectrets. In this chapter the authors confine themselves to a brief description of the fundamentals of the electrophotographic process and try to demonstrate that this phenomenon makes possible a convenient approach to investigations on the formation of the hidden electrophotographic image. The authors thank N. T. Kashukeyev, Senior Scientific Worker of the Physics Institute, Bulgarian Academy of Sciences; B. M. Golovin and L. M. Belyayev, Candidates of Physics and Mathematics; E. I. Adirovich, Doctor of Physics and Mathematics; G. Nadzhakov, Academician, Bulgarian Academy of Sciences (Sofia), editor of the book; A. V. Shubnikov, Academician; A. I. Belova; L. Ya. Mogilevskaya; and L. V. Duda. There are 136 references: 74 Soviet, 46 English, 14 German, and 2 Bulgarian.

PHASE I BOOK EXPLOITATION SOV/4379

Vsesoyuznaya konferentsiya po fizike dielektrikov. 2d, 1958

Fizika dielektrikov; trudy vtoroy vsesoyuznoy konferentsii (Physics of Dielectrics, Transactions of the 2d All-Union Conference on the Physics of Dielectrics) Moscow, Izd-vo AN SSSR, 1960. 532 p. Errata slip inserted. 5,000 copies printed.

Sponsoring Agency: Akademiya nauk SSSR. Fizicheskiy institut imeni P.N. Lebedeva.

Ed. of Publishing House: Ye.L. Starokadomskaya; Tech. Ed.: I.N. Dorokhina; Editorial Board: (Resp. Ed.) G.I. Skanavi, Doctor of Physics and Mathematics (Deceased), and K.V. Filippova, Candidate of Physics and Mathematics.

PURPOSE: This collection of reports is intended for scientists investigating the physics of dielectrics.

COVERAGE: The Second All-Union Conference on the Physics of Dielectrics held in Moscow at the Fizicheskiy institut imeni P.N. Lebedeva (Physics Institute imeni P.N. Lebedev) in November 1958 was attended by representatives of the principal scientific centers of the USSR and of several other countries. This collection contains most of the reports presented at the conference and summaries of the discussions which followed. The reports in this collection deal with dielectric properties, losses, and polarization, and with specific inductive capacitance of various crystals, chemical compounds, and ceramics. Photoelectrets, ferroelectric crystals, and various radiation and irradiation effects on dielectrics are investigated. The volume contains a list of other papers presented at the conference dealing with polarization, losses, and breakdowns of dielectrics, which were published in the journal Izvestiya AN SSSR, seriya fizicheskaya, Nos. 1 and 2, 1960. No personalities are mentioned. References accompany each report.

27998
S/194/61/000/004/041/052
D201/D302

24,2600 (1137, 1138, 1160)

AUTHORS: Zheludev, I.S. and Fridkin, V.M.

TITLE: Photoelectrets and electrophotography

PERIODICAL: Referativnyy zhurnal. Avtomatika i radioelektronika, no. 4, 1961, 2, abstract 4 E9 (Fizika dielektrikov, M., AN SSSR, 1960, 139-149 Discussion, 164-169)

TEXT: The formation of residual polarization under the action of illumination in a monocrystal corresponds to the formation in it of a photoelectretic state. The original symmetry of physical properties of the crystal is destroyed with it. Owing to internal polarization there is no center of polarization in photoelectrets (F), and they may then be referred to as piezoelectric materials. The piezoelectric polarization may be induced either by the past or present special polarizing force due to mechanical stress. A linear dependence exists between the piezoelectric and elasticity properties of F, the piezoelectric moduli being proportional to the

Card 1/3

Photoelectrets and electrophotography

polarization of F. The polarization of crystals, measurement of thus formed electric charge in F and the measurement of piezoelectric moduli, all above may be done using a special network. A cube of anthracene crystal is placed between the electrodes, its illumination being perpendicular to the direction of polarization. The value of the modulus of elasticity may be obtained in approximation from the charge density and piezoelectric moduli for F has been experimentally confirmed. Both the piezoelectric modulus and change of F decrease with time according to approximately the same law. F exhibit the pyro-electric effect, i.e. the change with temperature of the internal polarization. With increasing temperature the photopolarization of crystals sharply decreases. F may be used for electrophotography. The formation of a photoelectric picture on F is explained by the process of polarization and of depolarization with repeated illumination. A diapositive is placed at the surface of a previously polarized F and the surface is illuminated again through the diapositive. The illuminated regions are depolarized while the regions covered by the picture elements remain polarized,

Photoelectrets and electrophotography

thus forming a hidden picture. To reproduce this hidden picture the tribo-electric effect is used. The respective components of the tribo-electric mixture are charged +ve and -ve and sprinkled over the surface of F, at which they are retained only at spots where the polarization has been retained. The F with a paper sheet on it is placed in the field of a corona discharge. The positively charged particles are transferred to the paper and form a picture. The method corresponds to the positive-positive method. F with short circuited plates may be stored in darkness for a considerable time, although with time the intensity of the hidden picture decreases slightly. 25 references. [Abstracter's note: Complete translation]

4

Card 3/3

Zheludev, I.S.

S/181/60/002/04/24/034
B002/B063

24.7700
AUTHORS: Gurevich, V. M., Zheludev, I. S., Rez, I. S.

TITLE: The Problem of the Nature of Transitional Processes of Conductivity in Seignettoelectrics

PERIODICAL: Fizika tverdogo tela, 1960, Vol. 2, No. 4, pp. 691-696

TEXT: In a preceding paper (Ref. 1), the authors studied the transitional processes of conductivity in ceramic barium titanate and showed the interrelation between them and seignettoelectric polarization. In the present paper, they attempt to clarify the nature and mechanism of transitional processes of conductivity by comparing the properties of polycrystalline barium titanate, single crystals of Rochelle salt, guanidine-aluminum-sulfate hexahydrate (GAS) and triglycine sulfate. A comparison between the curves drawn and those of polarity reversal in $BaTiO_3$ and GAS (Figs. 3 and 4) shows the similarity of the two processes; the former, however, takes several minutes, and the latter only microseconds. The curves representing the transitional processes of conductivity and the motion of the domain walls in a Rochelle salt single crystal are shown in Fig. 5. The curves are identical, and the relationship between the transitional

Card 1/2

processes of conductivity and the orientation of the domains is thus confirmed. However, this contradicts the observation made on triglycine sulfate (Fig. 7). Mention is made of papers by A. F. Ioffe, Ye. V. Sinyakov, D. I. Prokopalo, V. N. Lozovskiy, M. D. Mashkovich, and S. I. Gorelik. The authors thank L. Z. Rusakov for interest in this work. There are 7 figures and 23 references: 15 Soviet, 3 American, 3 British, 1 Japanese, and 1 Hungarian.

SUBMITTED: February 26, 1959

24.2130

78114
SOV/70-5-1-23/30

AUTHORS: Gurevich, V. M., Zheludev, I. S., Rez, I. S.

TITLE: Electric Conductivity of Triglycinesulfate Single Crystals. Brief Communication.

PERIODICAL: Kristallografiya. 1960, Vol 5, Nr 1, pp 142-145 (USSR)

ABSTRACT: The electric conductivity of triglycinesulfate, whose other properties have become well known because of numerous studies since 1956, was examined at 20-78° C and the dielectric constant determined on the basis of obtained data. The method is described in the authors' earlier paper (Abstract 75998). Direct current was applied (to 10 x 10 x 0.3, 10 x 10 x 0.5, and 10 x 10 x 1 mm plates, cut off normal to X, Y, Z axes of the crystals) at different steady-state temperatures both below and above the Curie point (49° C). The plates normal to Y showed

Card 1/4

rectangular symmetric hysteresis loops, Ps was 2.4 microcoulomb per cm^2 and 240 v/cm coercive field at 24° C and 50 cycles. The plates normal to X and Z did not show hysteresis loops. The electric resistance ρ, om cm of the plates normal to Y and the temperature dependence of conductivity σ and dielectric constant ϵ are illustrated in Figs. 1 and 3, respectively. Conductivity vs temperature curves for the plates normal to X and Z show abrupt turns at 50° C (just above the Curie point). The resistance of plates does not change its value with the duration of experiments above the Curie point, and at any temperature along Z. There are 5 figures and 7 references; 6 Soviet, 1 U.S. The U. S. reference is: B. T. Matthias, C. E. Miller, J. P. Remeika, Phys. Rev., 104, 849, (1956).

SUBMITTED: July 11, 1959

MELESHINA, V.A.; ZHELUDEV, I.S.; REZ, I.S.

Application of the charged powder method to the study of the domain structure and morphological growth characteristics of triglycine sulfate crystals. Kristallografiia 5 no.2:322-323 Mr-Ap '60. (MIRA 13:9)

(Glycine) (Ferroelectric substances)

S/077/60/005/003/003/009
E032/E414

AUTHORS: Golovin, B.M., Zheludev, I.S., Kashukeyev, N.T. Pridkin, V.M. and Antonov, A.

TITLE: Electrophotography of Proton Beams 19

PERIODICAL: Zhurnal nauchnoy i prikladnoy fotografii i kinematografii, 1960, Vol.5, No.3, pp.207-208 + 1 plate

TEXT: A study is reported of the sensitivity of various electrophotographic layers to fast protons. The experiments were carried out on the synchrocyclotron of the Joint Institute for Nuclear Studies. The maximum intensity of the proton beam was about 10^8 protons/cm^2/sec and the energy of the protons was 680 Mev. Various electrophotographic layers were investigated, including ZnO, ZnS, CdS and polycrystalline sulphur, all deposited on paper. The electrophotographic layers were prepared by the method described in a previous paper (Ref.1). The layers were negatively charged by a corona discharge in air. The charged layers were then placed in a special holder which was fixed to the collimator with its plane perpendicular to the beam. After the exposure had been carried out the image was developed using a liquid electrophotographic developer described by two of the present authors in Ref.2. Dry

Card 1/3

S/077/60/005/003/003/009
E032/E414

Electrophotography of Proton Beams

developers (Ref.1) were used in the case of the sulphur layers. Fig.1 shows four electrophotographic images of the proton beam obtained in the ZnO layer with the beam in various angular positions relative to the axis of the collimator. As can be seen, these photographs can be used in the adjustment of the position of the proton beam. The electrophotographs shown in Fig.1 have a non-uniform background which is due to an edge effect associated with the electrostatic nature of the latent electrophotographic image. These edge effects can be reduced with the aid of a suitable screen. Fig.2 shows the photographs obtained with and without the screen (a and b respectively). It was found that electrophotographic layers of ZnO and polycrystalline sulphur are the most sensitive to protons. With maximum intensity of the proton beam, the minimum exposure time at 680 Mev was found to be 5 to 10 sec. It was found that the ZnO film has a similar characteristic curve to an X-ray film. The electrophotographic layer has a higher contrast but the latitude is smaller than in the case of the X-ray film. It follows that small irregularities in the beam are better defined in the electrophotographic method. Acknowledgments are expressed

Card 2/3

S/077/60/005/003/003/009
E032/E414

Electrophotography of Proton Beams

to V.P.Dzhelepov, Academician G.S.Nadzhakov and Academician A.V.Shubnikov for their interest. There are 4 figures and 2 Soviet references.

ASSOCIATIONS: Institut kristallografii AN SSSR (Institute of Crystallography AS USSR)
Institut fiziki Bolgarskoy AN (Institute of Physics of the Bulgarian AS)
Ob"yedinennyy institut yadernykh issledovaniy (Joint Institute for Nuclear Studies)

SUBMITTED: July 11, 1959

Card 3/3

S/070/60/005/003/010/024/XX
E132/E460

AUTHOR: Zheludev, I.S.

TITLE: The Full Symmetry of Scalars, Vectors and Second Rank Tensors

PERIODICAL: Kristallografiya, 1960, Vol.5, No.3, pp.346-353

TEXT: The concepts of the supplementary and the full symmetry of tensors are introduced. It is shown that there are 10 groups of full symmetry for second rank polar tensors (among them one scalar group and one axial vector group) and 10 groups for second rank axial tensors (among them one pseudoscalar group and polar vector group). Tables are given giving the canonical form of the tensor (the equalities between certain of the 9 components and the zero terms) for each kind of quantity (tensor, vector etc. and the various combinations of any two quantities). The symbol of the full symmetry (symmetry or antisymmetry point group) is given for each case as is a note on the special directions in which the tensor must be described for it to have the canonical form. The idea of supplementary symmetry means the inclusion of the antisymmetry properties of the tensor. A tensor which, after an affine transformation, has only changed the signs of certain of

Card 1/2

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E132/E460

The Full Symmetry of Scalars, Vectors and Second Rank Tensors

its components but has not changed their absolute magnitudes has undergone a symmetry operation which can be described by an antisymmetry point group. There are 2 tables and 1 Soviet reference.

ASSOCIATION: Institut kristallografii AN SSSR
(Institute of Crystallography AS USSR)

SUBMITTED: January 26, 1960

Card 2/2

85090

S/070/60/005/003/014/024/XX
E132/E460

24,3600 (1106, 1114, 1194)

AUTHORS: Vlokh, O.G. and Zheludev, I.S.

TITLE: Changes in the Optical Properties of Crystals Occurring on the Imposition of Electrical Fields (The linear Electro-Optical Effect) VI

PERIODICAL: Kristallografiya, 1960, Vol.5, No.3, pp.390-402

TEXT: By taking account of the changes of symmetry which arise on the application of an electric field along one of the more important directions in a crystal, the equation for the optical indicatrix has been calculated. This depends not only on the refractive indices but also on the magnitude of the electric field. The orientation of the new indicatrix with respect to the old is derived as a function of these variables. Tables give, for each of the 20 classes which can be piezoelectric and for several special directions of the applied field in each class, the symmetry class of the crystal in the applied field, the equations of the indicatrix in the coordinate system of the initial crystal class, the canonical equations for the indicatrix in the principal system of coordinates and the angles between the axes of crystalphysical and the principal systems of coordinates. The

Card 1/2

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E132/E460

Changes in the Optical Properties of Crystals Occurring on the Imposition of Electrical Fields (The Linear Electro-Optical Effect)

equations are all dependent on the field components, E_x, E_y and E_z. In general the indicatrix of a piezoelectric crystal is altered by the field, uniaxial crystals become biaxial and isotropic (cubic) crystals biaxial or uniaxial. Curie's or Neumann's principle can be applied to obtain the symmetry of the effects produced. There are 4 tables and 4 references: 3 Soviet and 1 English in Russian translation.

ASSOCIATION: L'vovskiy gosudarstvennyy universitet im.I.Franko
(L'vov State University imeni I.Franko)

SUBMITTED: January 27, 1960

Card 2/2

85091
S/070/60/005/003/015/024/XX
E132/E460

9.2180

AUTHORS: Romanyuk, N.A. and Zheludev, I.S.

TITLE: A Study of the Slow Electrical Polarization Processes in Rochelle Salt by Observations of the Domain Structure

PERIODICAL: Kristallografiya, 1960, Vol.5, No.3, pp.403-408

TEXT: Plates of X-cut Rochelle salt about 10 x 20 x 1 mm were silvered, except for an observation hole in each, and were examined with a polarizing microscope normal to their largest surfaces. An electric field of some 400 v/cm could be applied parallel to the direction of observation. Measurements were made at about 8°C. It was found that the single domain state produced by the field was rather unstable when the field was removed. The stability is less the smaller the initial domains; in these cases fields an order of magnitude greater than the coercive field are needed to produce a single domain structure. The single domain state is most stable if the majority of the initial domains were in the direction chosen for polarization. The observation that the crystal sooner or later returns to its original domain configuration indicates the exceptional stability of the latter. The change of area S with time of a growing component of a twin under the action

Card 1/2

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E132/E460

A Study of the Slow Electrical Polarization Processes in Rochelle Salt by Observations of the Domain Structure

of a field which is near to coercive field strength is approximately described by $S = k \exp(-\alpha/t)$ where t is the time since the application of the field and α depends on the field and the history of the specimen. This law seems to be applicable over a wide range of field strengths. There is no threshold field. The smallest field observed to produce a change is 20 v/cm. A crystal of Rochelle salt has a certain characteristic of "remembering" earlier states of domain structure. With the growth of the field strength the stability of the polarized state increasses and this leads to the growth of the coercivity. The observed decrease in the coercivity on repetition of the hysteresis cycle indicates that the first cycle in some measure produces conditions facilitating repolarization of the domains in succeeding cycles. There are 3 figures and 9 references: 3 Soviet, 3 Japanese and 3 English.

ASSOCIATION: Institut kristallografii AN SSSR
(Institute of Crystallography AS USSR)

SUBMITTED: December 19, 1959

Card 2/2

S/070/60/005/004/003/012
E132/E360

AUTHOR: Zheludev, I.S.

TITLE: The Limiting Groups of Complete Symmetry of Scalars, Vectors, Second-rank Tensors and Their Combinations

PERIODICAL: Kristallografiya, 1960, Vol. 5, No. 4, pp 508 - 512

TEXT: Counting the unit operation 1(no symmetry) there are 15 limiting groups of symmetry (groups containing one or more axes of order ∞). Antisymmetry elements (denoted by underlining the symbol) are included. A scalar has the symmetry $\infty/\infty.m$; a polar tensor $m.\infty:m$; an axial vector $\underline{m}.\infty:m$; a pseudoscalar $\infty/\infty.\underline{m}$; an axial tensor $\underline{m}.\infty:\underline{m}$ and a polar vector the symmetry $m.\infty:\underline{m}$. Others of the 15 groups can occur from combinations of scalars, vectors and tensors of different sorts and some of these are illustrated geometrically. The scheme by which one of these limiting groups passes to another when the various symmetry conditions are applied or relaxed is shown.

~~Card 1/2~~ Inst. Crystallography, AS USSR

S/070/60/005/005/011/017
E132/E360

AUTHORS: Gurevich, V.M. and Zheludev, I.S.

TITLE: The Anisotropy of the Electrical Conductivity of Single Crystals of Lithium Sulphate, $Li_2SO_4.H_2O$

PERIODICAL: Kristallografiya, 1960, Vol. 5, No. 5, pp. 805 - 806

TEXT: The conductivity of single crystals of $Li_2SO_4.H_2O$ has been measured in fields of 0.5 to 12,000 V/cm in the range 15 to 80 °C in a dry atmosphere with pre-dried specimens. No loss of water was detected. Measurements were made in the X, Y and Z crystallographic directions on specimens appropriately cut into cubes. The temperature dependence of conductivity was found to be $s = s_o \exp(-W / kT)$ where W, the dissociation energy, took values $W_x = 1.25$, $W_y = 1.12$ and $W_z = 1.04$ eV for the corresponding axes. No deviation from Ohm's law was found for the temperature range studied. When the air was moist (60-70% humidity) the surface conductivity was 6-10 times greater than the volume conductivity. The anisotropy found is

Card 1/3

S/070/60/005/005/011/017
E132/E360

The Anisotropy of the Electrical Conductivity of Single Crystals of Lithium Sulphate, $Li_2SO_4 \cdot H_2O$

in full conformity with the crystal symmetry. The microhardness was measured by the Khrushchev-Berkovich method as 17.55 kg/mm^2 in the X direction, 48.90 in the Y and 26.40 in the Z . This correlation of hardness with conductivity (maximum hardness with maximum conductivity and vice versa) is the opposite of that usually found for metals. The electrical strength in all directions is above 100 kV/cm. The effect of the spontaneous polarisation on the longitudinal conductivity could be observed; measuring along the pyroelectric axis (Y) the electrical conductivity in one direction was found to be 10% different from that in the other (e.g. resistivity = $[2.00 \pm 0.01] \times 10^{10}$ ohm cm one way and $[1.80 \pm 0.01] \times 10^{10}$ the other). This kind of measurement can only be made on pyroelectric crystals which are not ferroelectric because in the latter case the spontaneous

Card 2/3

S/070/60/005/005/011/017
E132/E360

The Anisotropy of the Electrical Conductivity of Single Crystals of Lithium Sulphate, $Li_2SO_4 \cdot H_2O$

polarisation will have its sign changed by the measuring field.
Acknowledgments are expressed to I.V. Gavrilova and I.S. Rez.
There are 1 figure and 5 references: 3 Soviet and 2 English.

SUBMITTED: February 27, 1960

Card 3/3

87806

S/070/60/005/006/005/009
E032/E314

9.2180 (3203, 1144, 1162)

AUTHORS: Romanyuk, N.A. and Zheludev, I.S.

TITLE: Polarization of Rochelle Salt by Single-Shaped Electric Pulses

PERIODICAL: Kristallografiya, 1960, Vol. 5, No. 6, pp. 904 - 911

TEXT: Abe (Ref. 1) has described an improved method for recording the polarization of Rochelle salt and has studied processes occurring in time intervals of between 10 and 12 sec. The present authors have extended the method so that it can be used to study polarization processes in Rochelle salt over time intervals of between a few tens of seconds and fractions of milliseconds. The modified method is described as follows. Consider a fully polarized specimen of an X-section of a Rochelle salt crystal placed in the extinguished position on the microscope stage. If the mutual disposition of the specimen and of the crossed Nicol prisms remains unaltered, then the intensity of

Card 1/5

87806

S/070/60/005/006/005/009
E032/E314

Polarization of Rochelle Salt by Single-shaped Electric Pulses

light leaving this system will depend on the direction of polarization in the specimen. In the case of partial polarization reversal, the amount of light transmitted will be a function of the degree of reversal. The light beam incident on the specimen was kept constant and both the current supplying the microscope lamp and the intensity leaving the microscope eyepiece for a given polarization state were stabilized. The light beam leaving the eyepiece was intercepted by the photocathode of a photomultiplier ФЭУ-18 (FEU-18) and the resulting signal was recorded on the screen of an oscillograph (ЭНО-1 (ENO-1)). Single rr-shaped electrical pulses 0,03-3 sec long were applied to the specimen from a pulse generator incorporating polarized relay (РП-5 (RP-5)). Longer pulses were applied directly to the specimen by switching on and off a battery. X-sections of Rochelle salt were investigated

Card 2/5

87806

S/070/60/005/006/005/009

E032/E314

Polarization of Rochelle Salt by Single-shaped Electric Pulses

(area 10 x 20 mm^2, thicknesses 0.5 - 1.0 mm). Silver electrodes were deposited on the specimens and had circular apertures at the centre. The diameter of these apertures was 4 mm and defined the region in the crystal which was investigated. The apertures in the electrodes were filled by drops of glycerin and were then covered with glass slides. The temperature of the specimen was kept constant to within $\pm$ 0.1 °C and was measured by copper-constantan thermocouples. The photocurrent was measured as a function of time by photographing the oscillograph traces. The change in the photocurrent corresponding to complete polarization of the specimen from one mono-domain structure to another was taken as equal to 100 units. The photocurrents were taken as the direct measure of the polarization. It was found that the polarization

Card 3/5

87806

S/070/60/005/006/005/009
E032/E314

Polarization of Rochelle Salt by Single-shaped Electric Pulses

reversal time as a function of the pulse amplitude, and the temperature dependence of this function, are in good qualitative agreement with analogous curves obtained by Pulvari and Kuebler in Refs. 9 and 10 and by Wieder in Ref. 8, who used ordinary electrical methods. Well-defined nonlinear and linear parts of these curves are observed and the slope of the latter is a function of temperature. Fig. 2 shows the dependence of the polarization (photo-current) on the amplitude of the applied pulses (V/cm) for different pulse lengths (1 - 2 sec, 2 - 1 sec, 3 - 0.4 sec, 4 - 0.15 sec, 5 - 0.07 sec and 6 - 0.03 sec; temperature = 15 °C). Fig. 3 shows the reciprocal of the polarization reversal time $1/\tau$ as a function of the pulse amplitude (1 - 8.8 °C, 2 - 10.7 °C, 3 - 15.5 °C, 4 - 14.7 °C,

Card 4/5

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S/070/60/005/006/005/009
E032/E314

Polarization of Rochelle Salt by Single-shaped Electric Pulses

5 - 20.4 °C and 6 - 23.4 °C). A study was also made of the spontaneous depolarization of Rochelle salt specimens. The results obtained are in good general agreement with previous results obtained by the present authors in. Refs. 5 and 6. There are 9 figures and 10 references: 4 Soviet and 6 non-Soviet.

ASSOCIATION: Institut kristallografii AN SSSR
(Institute of Crystallography of the AS USSR)

SUBMITTED: May 31, 1960

Card 5/6

9,2180

850 00

S/048/60/024/010/009/033
B013/B063

AUTHORS: Sonin, A. S., Zheludev, I. S., Dobrazhanskiy, G. F.

TITLE: The Piezoelectric Properties of $NaNO_2$

PERIODICAL: Izvestiya Akademii nauk SSSR. Seriya fizicheskaya, 1960, Vol. 24, No. 10, pp. 1209 - 1212

TEXT: The rule governing the variations of point symmetry during piezoelectric phase transitions, which was established by one of the authors and L. A. Shuvalov in Refs. 1 and 2, enabled the authors to develop a crystal-physical criterion for the determination of new piezoelectric substances. The question as to whether this criterion is really necessary and, if any, sufficiently exact, could not be answered so far and, therefore, requires further experiments on compounds with given changes of symmetry. Here, the authors describe the piezoelectric properties of $NaNO_2$. The sodium nitrate monocrystals bred by I. V. Gavrilova at the beginning of 1958 could, due to their high electrical conductivity, not be used for dielectric measurements. The crystals

Card 1/3

85000
S/048/60/024/010/009/033
B013/B063

The Piezoelectric Properties of $NaNO_2$

examined in the present work were grown from a chemically pure trade-marked material melting at 271°C, using a modified method described by Obreimov and Shubnikov in Ref.10. The measurements were made by means of Vobzer's water thermostat between room temperature and 100°C and by means of a thermostat filled with an organo-silicon solution No. 5 between 100° and 200°C. The dielectric constant was measured at 500 kilocycles. Figs. 1 and 2 show the temperature dependence of the dielectric constant on three crystallographic axes. It may be seen that the dielectric constants have distinct peaks at the phase-transition temperatures. A Scheme providing for the compensation of conductivity (Ref.11) was used to study the dielectric hysteresis loops at 50 cycles. The shape of the hysteresis loop at 165°C (Fig.3) is indicative of the high conductivity of the crystal. Spontaneous polarization and coercive force were calculated from the hysteresis loops. The temperature dependences of these quantities are illustrated in Figs. 4 and 5. The shape of the hysteresis loops and the temperature dependence of the coercive force indicate the considerable hardness of $NaNO_3$ between room temperature and 147°C, the spontaneous polarization and the coercive

Card 2/3

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The Piezoelectric Properties of $NaNO_2$

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B013/B063

force decreasing near the Curie point. The deviation of the authors' results from the values mentioned in Ref.9 is related to the varying conditions of crystal growth. The authors thank V. I. Pakhomov and G. M. Lobanova for the preparation of the samples; I. Fenina for assistance in the experiments; and L. A. Shuvalov and I. S. Rez for a discussion of the measurements. The present paper was read at the Third Conference on Piezoelectricity, which took place in Moscow from January 25 to 30, 1960. There are 5 figures and 11 references: 6 Soviet.

ASSOCIATION: Institut kristallografii Akademii nauk SSSR (Institute of Crystallography of the Academy of Sciences USSR)

Card 3/3

85003

S/048/60/024/010/012/033
B013/B063

9.2180

AUTHOR: Zheludev, I. S.

TITLE: Oscillations of Dielectric Pendulums and Polarization of Ferroelectrics

PERIODICAL: Izvestiya Akademii nauk SSSR. Seriya fizicheskaya, 1960, Vol. 24, No. 10, pp. 1225-1227

TEXT: Following Ref. 1 which deals with natural and forced oscillations of dielectric pendulums, the author now attempts to establish a qualitative relationship between these phenomena and the polarization of the dielectric. The experiments were made by the method described in Ref. 1. Fig. 1 shows forced pendulum oscillations as a function of the strength of an alternating field for the case where sheets of the X-cut of Rochelle salt crystals were used as the active element of the pendulum. This indicates a marked dependence of the oscillation amplitude on the polarization of the sample. The function $A_0 = A_0(E)$ shown in Fig. 1 corresponds to the function $P = P(E_m)$ for piezoelectric substances. The relationship between the pendulum oscillation and the polarization of the sample and its domain

Card 1/2

85003

Oscillations of Dielectric Pendulums and Polarization of Ferroelectrics

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B013/B063

structure is also confirmed by Fig. 2. Therefrom it may be seen that the oscillation amplitude of the pendulum decreases with a decrease of the polarization produced by the application of a constant field, and that practically no oscillations occur any longer when the domain structure is entirely "compressed". Furthermore, the author made experiments with a barium titanate pendulum, which was placed in a vacuum. When an alternating field was applied, the pendulum oscillations were found to be subject to the same rules as hold in the air. The author thanks S. V. Rozhkov and A. Yu. Kurkovskiy for their assistance in his experiments. The present paper was read at the Third Conference on Piezoelectricity, which took place in Moscow from January 25 to 30, 1960. There are 2 figures and 3 Soviet references.

ASSOCIATION: Institut kristallografii Akademii nauk SSSR (Institute of Crystallography of the Academy of Sciences USSR)

Card 2/2

85874

24.7800 (1144, 1162)
9.2181 (2303, 3203)

S/048/60/024/011/010/036
B006/B056

AUTHORS: Gurevich, V. M. and Zheludev, I. S.

TITLE: The Ferroelectric Properties of Triglycine Sulfate Monocrystals in the Frequency Range of 0.01 - 50 cps

PERIODICAL: Izvestiya Akademii nauk SSSR. Seriya fizicheskaya, 1960, Vol. 24, No. 11, pp. 1342 - 1346

TEXT: The present paper is a reproduction of a lecture delivered on the 3rd Conference on Ferroelectricity, which took place in Moscow from January 25 to 30, 1960. In an earlier paper (Ref.1) the authors investigated triglycine sulfate (TGS) monocrystals at very low frequencies, especially 0.01 cps, and found anomalous hysteresis loops. Now investigations are being continued on an improved apparatus with photographic recording of the hysteresis loops, and the range was extended to 50 cps. It was possible to show that the anomalies may be observed not only at very low frequencies, but in the entire range investigated. A block diagram of the experimental arrangement is shown in Fig.1. The arrangement differs from the usual types by the fact that an alternating sinusoidal

Card 1/2

voltage had been applied to the sample and that an inertialess oscilloscope was used as an indicator. The hysteresis loops (Fig.2) confirmed the frequency and E-dependency of the coercive force of TGS crystals, which had already been found to exist in Ref.1. The quantitative conditions may be seen from Fig.3. As the hysteresis loops become broader with increasing voltage, this means that also the losses increase with E. Fig.4 shows this (tan δ is shown as a function of E and temperature). Fig.6 shows the temperature dependence of ε and the polarization P_s at 10^6 cps, of the latter measurements are compared with the values from Ref.6 (Curve 3). Fig.7 shows the influence exerted by frequency and field strength upon the shape of the hysteresis loops. The authors thank I. V. Gavrilova and M. F. Koldobskaya for the TGS crystals and I. S. Rez for discussions. There are 7 figures and 6 references: 3 Soviet and 3 US.

ASSOCIATION: Institut kristallografii Akademii nauk SSSR (Institute of Crystallography of the Academy of Sciences USSR)

85895

9.2180 (3203, 1162)
24.7800 (1144, 1162)

S/048/60/024/011/031/036
B006/B060

AUTHORS: Mamonov, Ye. I. and Zheludev, I. S.

TITLE: Some Special Properties of Seignettoelectric Materials and Ferromagnetic Toroids With Rectangular Hysteresis Loop

PERIODICAL: Izvestiya Akademii nauk SSSR. Seriya fizicheskaya, 1960, Vol. 24, No. 11, pp. 1421 - 1425

TEXT: This is the reproduction of a lecture delivered at the Third Conference on Ferroelectricity which took place in Moscow from January 25 to 30, 1960. The paper under consideration gives results concerning the polarity reversal characteristics. Details relative to hysteresis are first dealt with. Fig. 1 shows a loop recorded oscillographically and exhibiting the characteristic time marks, type, and position of which allow the rates of polarity or magnetic reversal to be inferred. The polarization (magnetization) of seignettoelectric (ferromagnetic) elements is much quicker in the vertical part of the

Card 1/4

85895

Some Special Properties of Seignetto-electric Materials and Ferromagnetic Toroids With Rectangular Hysteresis Loop

S/048/60/024/011/031/036
B006/B060

loop than in the horizontal one. The commercial use of such elements requires the quickest switching possible; here the switching regulation principle is a pulsed one. Fig. 2 shows the signals of the switching of such elements. The study also covered the switching duration τ as a function of the field strength applied. Fig. 3 shows τ and $1/\tau$ as functions of H and E. $1/\tau = \mu(E-E_0)$ and for seignettoelectric materials $1/\tau = (1/S)(H - H_0)$, where μ is the domain mobility coefficient and S is the switching coefficient; both of the coefficients are dependent upon the physical and chemical parameters of the material. Measurement data of various specimens are compiled in a table. The final discussion comprises some details concerning losses (line losses, losses due to piezoeffect and electrostriction or eddy currents and magnetostriction, respectively; losses due to relaxation processes). There are 3 figures, 1 table, and 4 references: 2 Soviet and 2 US.

ASSOCIATION: Institut kristallografii Akademii nauk SSSR (Institute of Crystallography of the Academy of Sciences USSR)

Card 2/4

S/048/60/024/011/035/036
B006/B060

24,7800

AUTHOR: Zheludev, I. S.

TITLE: Common and Differentiating Aspects in Antisymmetry, Magnetic Symmetry, and Total Symmetry

PERIODICAL: Izvestiya Akademii nauk SSSR. Seriya fizicheskaya, 1960, Vol. 24, No. 11, pp. 1436 - 1439

TEXT: This is the reproduction of a lecture delivered at the Seminary on the Theory of Ferroelectricity on April 18, 1960. The author proceeds from the representations introduced by A. V. Shubnikov into the theory of space groups to give a survey of the prospects opened by studies conducted by himself and other authors in the field of the group-theoretical investigation of symmetry- and antisymmetry properties. In this connection, special mention is made of the generalization introduced by B. A. Tavger and V. N. Zaytsev for describing the magnetic properties of crystals, the so-called "magnetic symmetry". The proof given by L. D. Landau and Ye. M. Lifshits that time reversal operations constitute no symmetry

Card 1/2

Common and Differentiating Aspects in Antisymmetry, Magnetic Symmetry, and Total Symmetry

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B006/B060

operations for magnetic properties was made use of in this connection. Methods and difficulties involved by this generalization are discussed and compared, from the group-theoretical point of view, with the generalizations for the description of antisymmetry. The relationships existing between antisymmetry operations and operations of total symmetry are discussed and compiled in a table. The vector and tensor representations of some total symmetry groups are discussed and the generalizations in total symmetry are considered. It is finally pointed out that the latter can be successfully used for describing the symmetry and the special properties of pyro-, seignetto-, and anti-seignettoelectric materials. There are 1 figure, 1 table, and 11 Soviet references.

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ASSOCIATION: Institut kristallografii Akademii nauk SSSR (Institute of Crystallography of the Academy of Sciences USSR)

Card 2/2

ZHELUDEV, I. S.

Doc Phys-Math Sci - (diss) "Several electrical properties of crystals. Pyro-, piezo-, and ferroelectric crystals in view of their symmetry." Moscow, 1961. 19 pp; (Moscow State Univ imeni M. V. Lomonosov, Physics Faculty); 150 copies;free; (KL, 7-61 sup, 217); list of author's works at end of text (24 entries)

22872
S/077/61/006/004/004/004
D051/D113

24.3500 1035, 1138, 1155
3.1205 (1395)

AUTHORS: Zheludev, I.S.; Barulin, Yu.N.; and Fridkin, V.M.

TITLE: On a new version of the process of electronic photography

PERIODICAL: Zhurnal nauchnoy i prikladnoy fotografii i kinematografii, v. 6, no. 4, 1961, 300-301

TEXT: The authors propose a new method of electronic photography which is essentially different from the usual versions where the latent image is dependent upon the distribution of charges on the layer surface. The method excludes the use of any developers known in electronic photography. It is based on the application of a reverse electrical field and the photographic process is negative. Previous investigations (Ref. 1) revealed electroluminescence of permanently polarized ZnS layers under the action of a constant electric field. The duration and intensity of this phenomenon, which is particularly pronounced in ZnS-Cu polycrystalline layers when a constant electric field opposite in direction to that of the initial field is applied, depend on the charge density of the layer surface and on the initial field is applied, erties. It was established (Ref.1) that when such a polarized layer properradiated in the near infrared region, an uncommon extinguishing effect is

Card 1/3

On a new version of the process ....

observed, consisting in a diminution of luminescence on the application of the reverse electric field to the layer. On radiation the density of the surface charge remained practically unchanged, i.e. the indicated effect is not due to depolarization. Experiments were conducted in order to obtain and visualize the latent image on ZnS-Cu layers according to the above-mentioned method. Activated ZnS powder was dispersed in an alcohol solution of polyvinylbutyral. The layers, which were approximately 100μ thick and coated on paper, were subjected to a corona discharge and exposed through a negative film. A standard incandescent bulb, where $T_{lum} = 2850^{\circ}K$, served as the light source. The use of light filters permitted the layer to be exposed in different spectral regions. The latent image was visualized by applying a reverse electric field to the exposed layer. In this way images could be obtained in the near infrared region for $\lambda < 1.1\mu$. At present, the sensitometric aspects of this process, the resolving power of the layer, and other characteristics are being investigated. The authors also emphasize that the process studied by them is basically different from the photographic process described by H.Kallmann and J. Rennert (Ref. 2: J.Opt.Soc.America, 1958, 48, 812). I.N. Orlov and A.M.Bonch-Bruyevich are thanked for their help.

Card 2/3

22872
S/077/61/006/004/004/004
D051/D113

On a new version of the process ....

[Abstracter's note: essentially full translation] . There are 2 references: 1 Soviet and 1 non-Soviet-bloc reference.

ASSOCIATION: Institut kristallografii AN SSSR (Institute of Crystallography AS USSR)

SUBMITTED: January 4, 1961

Card 3/3

25893
S/070/61/006/004/005/007
E032/E314

9,2180 (1331, 1144, 1063)

AUTHORS: Fotchenkov, A.A., Zheludev, I.S. and Zaytseva, M.P.

TITLE: Electrostriction of Single Crystals of Rochelle Salt

PERIODICAL: Kristallografiya, 1961, Vol. 6, No. 4, pp. 576 - 581

TEXT: In distinction to linear dielectrics (Ref. 1 - Fotchenkov and Zheludev - Kristallografiya, 1958, Vol. 3, No. 3, pp. 308-314) ferroelectrics exhibit a much greater electrostriction effect. Up to now, the electrostriction coefficients of ferroelectrics have been largely measured by indirect methods. Allsopp and Gibbs (Ref. 11 - Philos. Mag. 1959, Vol. 4, No. 39, pp. 359-370), G. Schmidt (Ref. 10 - Z. Physik, 1956, 145, pp. 534-542; Ref. 12 - Naturwissenschaften, 1958, Vol. 45, No. 1, pp. 8-9) are said to have been the first to determine the electrostriction coefficients of barium titanate by direct measurement of the deformation which appears under the action of an electric field. In previous work, the electrostriction coefficients were determined

Card 1/

Electrostriction of ....

from the relation between the deformation of the specimen and the square of the spontaneous polarisation. No account was taken of the effects due to the reorientation of the domains in the electric fields. The present authors define the electrostrictional deformation of ferroelectrics as the deformation which is proportional to the square of the electric field independently of the mechanism giving rise to the deformation. The apparatus described by the first of the present authors in Ref. 13 (Kristallografiya, 1957, Vol. 2, No. 5, pp. 653 - 657) has been used to carry out a detailed study of the electrostriction properties of Rochelle salt. Particular attention was paid to electrostrictional deformation due to reorientation in the domain structure. In the present work, the degree of polarization of Rochelle-salt specimens and their phase-transition temperature were controlled with the aid of the hysteresis loop obtained in the "usual way". The Rochelle-salt specimens (5 x 10 x 20 mm along the X, Y and Z axis) were placed in a thermostated crystal holder described by the first of the present authors (Ref. 14 - Kristallografiya, 1960, Vol. 5, No. 3, pp. 415 - 419).

Electrostriction of ....

The electrodes were in the form of silver foil and the deformation of the specimen was measured at twice the frequency of the applied sinusoidal voltage. Fig. 2 shows the dependence of the electrostriction of a Rochelle-salt specimen (X section) on the magnitude of the applied electric field (V/cm) at 600 kc/s and $T = 22\ ^{\circ}C$. The thickness of the specimen was 2 mm. Curve 1 shows the electrostrictional deformation r'_{11} and Curve 2 the electrostriction coefficient r_{11}. Fig. 3 shows the dependence of the electrostriction coefficient R_{11} for Rochelle salt as a function of a (constant) polarizing field (V/cm) with $E_{\sim} = 140$ V/cm and $T = 12\ ^{\circ}C$. Consideration of this figure shows that even small constant fields remove from the polarization reversal process a large fraction of the domains. A comparison is then made between the electrostriction coefficient R_{11} for Rochelle salt and the coefficient Q_{11} as reported by Mason (Ref. 2 - Piezo-electric Crystals and Their Application in Ultra-acoustics. Izd. IL, Moscow, 1952).

Card 3/9

Electrostriction of ....

The two coefficients are related by:

$$R_{11} = (\varepsilon_{11}^{t}/4\pi)^2 Q_{11}$$

where ε_{11}^{t} is the dielectric constant. It was found that with $E_{\sim}$ = 380 V/cm, ε_{11}^{t} = 160 . For the same field $R_{11} \approx 0.07 \times 10^{-6}$ CGSE and hence $Q_{11} \approx 430 \times 10^{-2}$. This is greater by a factor of 5 than the value reported by Wood and Mason. It is stated that the discrepancy may be due to some unknown errors in the results of Wood and Mason, who measured the spontaneous polarisation from the hysteresis loops while the spontaneous deformation was measured in the polydomain state. Fig. 4 shows the temperature dependence (heating) of the electrostrictional deformation of Rochelle salt (X section) for different values of the alternating field (Curve 1 - $E_{\sim}$ = 110 V/cm; Curve 2 - $E_{\sim}$ = 90 V/cm; Curve 3 - $E_{\sim}$ = 70 V/cm). The traces on the right were obtained

Electrostriction of ....

with $E_{\sim}$ = 110 V/cm; temperatures are indicated below the loops. Finally, Fig. 5 shows the temperature dependence of R_{11}, calculated from the data shown in Fig. 4 (Curves 1, 2 and 3 correspond to $E_{\sim}$ = 110, 90 and 70 V/cm, respectively). The general conclusion is that all the relationships obtained can be explained on the basis of the behaviour of the domain structure in an electric field. A schematic representation of the deformation of a ferroelectric in an alternating electric field is shown in Fig. 1, in which Curve 1 shows the applied field and Curve 2 the deformation as a function of time. The diagrams below the graphs illustrate the mechanism of the deformation of the crystal and the domain-reorientation process. Acknowledgments to I.M. Sil'vestrova and L.A. Skopina for carrying out the experiments.
There are 5 figures and 15 references: 8 Soviet and 7 non-Soviet. The four latest English-language references quoted are: Ref. 3 - W.P. Mason - Phys. Rev., 74, 1131-1147, 1948; Ref. 5 - M.E. Caspari, W.J. Merz - Phys. Rev., 80, 1082-1089, 1950; Ref. 7 - W.H. Bond, W.P. Mason and

25893
S/070/61/006/004/005/007
E032/E314

Electrostriction of ....

H.J. McSkimin - Phys. Rev., 82, 442, 1951:
Ref. 11 - A.H. Allsopp, D.F. Gibbs - Philos. Mag., 4, 39, 359-370, 1959.

ASSOCIATION: Institut fiziki Sibirskogo otdeleniya AN SSSR (Institute of Physics of the Siberian Branch of the AS USSR)
Institut kristallografii AN SSSR (Institute of Crystallography of the AS USSR)

SUBMITTED: January 9, 1960

Card 6/9

26645
S/070/61/006/005/003/011
E132/E560

24.7800 (1137, 1138)

AUTHORS: Zheludev, I.S., Filimonov, A.A., Yurin, V.A. and Romanyuk, N.A.

TITLE: The observation of the domain structure of ferroelectric crystals by means of electroluminescent materials

PERIODICAL: Kristallografiya, 1961, Vol.6, No.5, pp.676-680 + 1 plate

TEXT: A basically new method of showing up the domain structure of a ferroelectric has been tried out. It consists in using a paste of ZnS in a silicone oil spread on one surface of a plate of the crystal cut perpendicular to the ferroelectric axis. An electrode is applied to the opposite surface and a transparent electrode is firmly pressed down on to the luminescent paste. A glass plate coated with SnO_2 will serve as the latter. When an alternating voltage is applied across the assembly the field divides itself between the two layers inversely as the dielectric constants. A frequency below 1 kc/s was used, higher frequencies giving too much heating. A constant field can be applied to hold the domain structure fixed. The polarization of the domains then

Card 1/2

adds and subtracts from the alternating field and at the optimum value regions oppositely polarized can be seen as light and dark. The method has been successfully tried for specimens of triglycine sulphate and guanidine aluminium sulphate. Specimens with the domain structure stabilised by irradiation with gamma-rays have been preferred. These have a very large hysteresis for the reversal of the polarization of the domains and are not so disturbed by the applied voltage as other specimens. The resolving power is poor. There are 5 figures and 18 references: 13 Soviet and 5 non-Soviet. The English-language references read as follows: Ref.1: W. I. Merz. Phys. Rev., 95, 3, 690, 1954; Ref.8: H. Toyoda, S. Waku, H. Hirabayashi. J. Phys. Soc. Japan, 14, 8, 1003, 1959; Ref.9: G. L. Pearson, W. L. Feldman. Bull.Amer. Phys. Soc., 7, 336, 1958.

ASSOCIATION: Institut kristallografii AN SSSR (Institute of Crystallography AS USSR)

SUBMITTED: March 11, 1961

GUREVICH, V.M.; ZHELUDEV, I.S.

Anomalous conductance in the phase transition region and anisotropic conductance of triglycinefluoberyllate single crystals. Kristallografiia 6 no.5:778-779 S-O '61.
(MIRA 14:10)

(Fluoberyllate—Electric properties)
(Glycine)

34733
S/070/62/007/001/019/022
E039/E435

AUTHORS: Yurin, V.A., Baberkin, A.S., Zheludev, I.S.

TITLE: The influence of γ-radiation on ferroelectric properties of crystals of guanidine (aminomethanamidine) aluminium sulphate

PERIODICAL: Kristallografiya, v.7, no.1, 1962, 147-150

TEXT: Preliminary results are presented of an investigation of the influence of γ-radiation on the ferroelectric property of a single ferroelectric crystal of guanidine aluminium sulphate (G A S) $C(NH_2)_3Al(SO_4)_2 \cdot 6H_2O$. The sample was placed in a holder with electrodes and arranged so that its hysteresis loop could be directly observed during the exposure (carried out at room temperature). The exposure of a non-polarized sample caused its normal single hysteresis loop to change gradually into a double loop (see Fig.1 a, б). The critical field E_{cr} increased proportionally with the dose of radiation. At the same time the coercive field E_{coer} increased in both halves of the double loop. If the exposure was carried out after applying to the sample a constant field $E_=$ greater than its saturation

The influence of γ-radiation ...

field E_{sat} (i.e. single domain condition) then, after irradiation and removal of $E_{=}$, instead of a double hysteresis loop there was a single displaced loop (Fig.1в). The displacement field E_{dis} also increased proportionately with radiation dose. The direction of displacement was opposite to that of the external field $E_{=}$. No noticeable increase in saturated polarisation P_{sat} was observed up to the maximum dose applied (80 Mr). There are 2 figures.

ASSOCIATION: Institut kristallografii AN SSSR
(Institute of Crystallography AS USSR)

SUBMITTED: July 14, 1961

S/070/62/007/003/007/026
E132/E460

AUTHORS: Yurin, V.A., Sil'vestrova, I.M., Zheludev, I.S.

TITLE: The ferroelectric properties of crystals of triglycine sulphate irradiated by γ-rays

PERIODICAL: Kristallografiya, v.7, no.3, 1962, 394-402

TEXT: An experimental investigation has been made of the influence of gamma rays on the form and parameters of the hysteresis loop, the influence of steady electric fields and of the temperature on the hysteresis loops of irradiated crystals, and the influence of the γ-rays on the dielectric properties of triglycine sulphate $(NH_2CH_2COOH)_3H_2SO_4$. The results are compared with analogous data for Rochelle salt containing Cu ions. Like the Cu^{++} ion, the products of the radiolysis of TGS are charged and interact with the spontaneous internal polarization field. In an applied external field, the radiolysis products redistribute themselves leading to changes in the hysteresis loop (which splits into two loops or may be displaced). The rearrangement of the products tends to stabilize the spontaneous polarization in a particular direction and a much stronger field is required to move it. The greater

Card 1/2

the dose the more stable the configuration. Electron paramagnetic resonance has shown the presence of free radicals in irradiated TGS confirming this interpretation. There are 7 figures.

ASSOCIATION: Institut kristallografii AN SSSR
(Institute of Crystallography AS USSR)

SUBMITTED: July 17, 1961

S/070/62/007/003/021/026
E132/E460

AUTHORS: Zheludev, I.S., Lelekov, V.S.

TITLE: The converse piezoeffect in Z-cut crystals of guanidine aluminium sulphate (GAS)

PERIODICAL: Kristallografiya, v.7, no.3, 1962, 463-465

TEXT: Normally, the direct measurement of the piezoelectric coefficients in the regime of the converse piezoelectric effect is extremely rare but in the case of GAS it happens to be possible. The modulation interferometry described by G.S.Gorelik (Dokl. AN SSSR, v.83, no.4, 1952, 549) and I.L.Bershteyn (Dokl. AN SSSR, v.94, no.4, 1954, 655) is used. Periodic displacements down to amplitudes of 0.05 Å can be measured at 20 to 26000 c/s over a temperature interval of -20 to +100°C corresponding to an accuracy in the piezomoduli of 0.5 to 1%. d_{33} for GAS has been measured for polarizing fields up to 60 kV/cm at 900 c/s. Typical curves for unipolar and non-unipolar specimens of Z-cut GAS are given. It was possible to measure the field which would be required to give a non-polar crystal a polarization equal to that produced spontaneously - this field is 270 kV/cm and corresponds to a

Card 1/2

spontaneous polarization of 0.33×10^{-6} coul/cm^2 in good agreement with values obtained from the hysteresis loop. There is 1 figure. [Abstracter's note: The substance is stated to be guanidine aluminium sulphate - GAS but it is probable that the hydrate GASH is meant.]

ASSOCIATION: Institut kristallografii AN SSSR
(Institute of Crystallography AS USSR)

SUBMITTED: September 26, 1961

Card 2/2

39860
S/070/62/007/004/007/016
E132/E435

24.2800

AUTHORS: Zheludev, I.S., Tagiyeva, M.M.

TITLE: The electrical polarization of pyroelectric crystals on isotropic compression (or extension)

PERIODICAL: Kristallografiya, v.7, no.4, 1962, 589-592

TEXT: The piezoelectric moduli for hydrostatic compression or extension d_{hydr} have been measured for crystals of tourmaline, potassium tartrate, lithium sulphate and ramnose. From these values the spontaneous polarization has been calculated. The dependence of the unipolarity of X-cut specimens of Rochelle salt on area has been studied. The specimens, cut into plates perpendicular to their pyroelectric axes, were compressed by gaseous N_2 from a cylinder, earthed and then, after release of the pressure, the charges generated were measured by an electrometer. A thermocouple measured the temperature of the specimens. The accuracy was about 4%. Temperature changes are considered not to affect the measurements. The spontaneous polarization P_o is calculated from the formula

$$P_o(s_{33} - s_{11} - s_{22} - 2s_{12}) = d_{hydr}$$

Card 1/2

The electrical polarization ...

where s_{ij} are the compliance constants. Experiments were made with crystals of Rochelle salt of different areas and the specific charge was plotted against the area of the plate. The unipolarity is large for specimens less than 1 cm^2 and does not become small until the area is above 6 cm^2. The unipolarity depends on the domain structure of the crystals. There are 2 figures and 1 table.

ASSOCIATION: Institut kristallografii AN SSSR
(Institute of Crystallography AS USSR)

SUBMITTED: September 9, 1961

ZHELUDEV, I.S.; VLOKH, O.G.

Morphological symmetry of pentaerythrite crystals. Kristallografiia 7 no.5:784-785 S-O '62. (MIRA 15:12)

1. Institut kristallografii AN SSSR.
(Erythrite crystals)

S/070/62/007/005/012/014
E132/E460

AUTHORS: Zheludev, I.S., Tikhomirova, N.A., Fridkin, V.M.

TITLE: The ferroelectric properties of triglycine sulphate under high hydrostatic pressure

PERIODICAL: Kristallografiya, v.7, no.5, 1962, 795-797

TEXT: The conductivity and ferroelectric properties of crystals of triglycine sulphate have been measured under hydrostatic pressures of up to 25000 atm. The pressure was applied in a multiplier, isopentane being used to transmit the pressure, which was measured with a manganin resistance manometer to an accuracy of 100 kg/cm^2. The temperature was controlled to 1°C and the hysteresis loop at 50 c/s was recorded together with the susceptibility at 800 c/s. With increasing pressure the height of the loop (spontaneous polarization) decreases by a factor of 3 at the highest pressure and the coercive field increases slightly. The dielectric constant decreased monotonically with pressure to about 50% of its value at atmospheric pressure. The reverse current increased by a factor of about 2 and the Curie temperature rose by 1.6 x 10^{-3} °C/atm. The results show that at

superhigh pressures the orientation of the domains is hindered and adsorption gives place to electroconductivity, ionic or electronic. There are 4 figures.

ASSOCIATION: Institut kristallografii AN SSSR
(Institute of Crystallography AS USSR)

SUBMITTED: December 20, 1961

Card 2/2

ZHELUDEV, I.S., inzh.; MARTYNOV, V.M., inzh.

Redesigning a shop making gypsum-concrete slabs. Stroi.mat 8 no.10:25-26 O '62. (MIRA 15:11)
(Gypsum products)

ZHELUDEV, I. S.

"The Definition of Antitensors and their Symmetry."

report presented at the Int. Symposium on Protein Structure and Crystallography, Madras, India, 14-18 January 1963.

Inst. of Crystallography, Acad. Sci. USSR